

FREQUENTLY ASKED QUESTIONS

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Content Questions

When do you use force or potential energy for gravitation problems?

There's no specific rule, but if you are asked about force or force balance, then you probably want to use the universal law of gravitation. When you are asked to find the velocity at a particular point, often conservation of energy will work well. Sometimes you might need to try a couple of things.

What's the difference between escape velocity and the velocity at some distance?

Escape velocity (strictly, speed) refers to the speed you need to launch an object with in order for it to just reach infinity (with zero velocity); you find it using conservation of energy and setting kinetic energy to zero at infinity (and using the potential energy which is zero at infinity). You can use energy conservation to find velocities at other points, too.

What's the difference between buoyancy and pressure?

“Pressure” is a general term meaning force per unit area, for any force which is distributed over a surface. It can apply to solid objects as well as fluids. For an object immersed in a fluid, there's a contact force exerted by the fluid on all surfaces of the object. Since this fluid contact force is a distributed force, it's called a pressure. For a static situation, the pressure force is normal to every interface.

“Buoyancy” is a more specific term. It refers to the net force experienced by an object immersed in a fluid due to contact with the fluid. Its origin is the difference in pressure between the top and bottom of an object. The bottom of an object is deeper (farther from the surface), and hence the pressure is higher on the bottom than the top, by Pascal's law— this leads to a net buoyant force on the object upward from pressure (the *overall* net force, including gravity, may be upward or downward, depending on mass

of the object). The buoyant force on a object is proportional to the volume displaced, according to Archimedes' principle.

How do you calculate volume displaced in a fluid?

It depends on what information you have. If you know the volume of the object, and the object is completely submerged: then volume displaced is just the volume of the object. Sometimes you can figure out volume displaced by employing Archimedes' principle and/or static equilibrium. For example, suppose you have something floating on water, partially submerged. You know its weight, although maybe you don't know the volume submerged (which is the volume displaced). From Archimedes you know that the buoyant force is $\rho V_{\text{displ}}g$. From static equilibrium you know that the weight is equal to this, *i.e.* $\rho V_{\text{displ}}g = W$. We can then get that $V_{\text{displ}} = \frac{W}{\rho g}$. For other problems, depending on the details, you may be able to set up various equations to get displaced volume.

Where does Bernoulli's equation come from? How do the units work?

Bernoulli's equation comes from requiring conservation of energy in a flowing fluid. It's derived in your textbook. It says that $P + \frac{1}{2}\rho v^2 + \rho gy = \text{constant}$, where ρ is the density and y is the height. The second term is related to kinetic energy of the fluid, and the third term is related to gravitational potential energy (near the surface of the Earth): you can see that these terms resemble $\frac{1}{2}mv^2$ and mgy for point particles. At two points along a flow, $P_1 + \frac{1}{2}\rho v_1^2 + \rho gy_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho gy_2$ and the pressure difference $P_1 - P_2$ is related to work done.

You can check the units for each term: they will come out to be N/m^2 (try it).

How do you approach Problem 14-71?

To find x , the distance at which the stream hits the ground, you need to find the velocity v with which the stream comes out of the hole; if you have this, you can just use 1D kinematics. Now to find v , use Bernoulli, realizing that the pressure is atmospheric where the water is in contact with the air.

For part *b*, use your expression for x in terms of H and h to solve for possible values of h , given x and H .

For part *c*, find the value of h that maximizes $x = f(h)$.